3 REVIEW OF EXISTING DATA

3.1 SUMMARY OF PREVIOUS INVESTIGATIONS

Historical data that were evaluated for possible inclusion in the current RI/FS originated from the following investigations:

- Site Inspection Report (E&E 1987)
- Site Hazard Assessment (Parametrix 1991)
- Wetland Mitigation Plan at Little Squalicum Creek (DEA 1993)
- Site Inspection Prioritization Report (URS 1994)
- Expanded Site Investigation (E&E 1996)
- Removal Assessment, Phase II (E&E 1998a,b)
- OESER Company RI/FS (E&E 2002a,b)
- Little Squalicum Creek Screening Level Assessment (Ecology 2004).

Site sampling locations from these previous investigations are shown on Figures 3-1 through 3-4. A Microsoft Database containing the analytical results for these historical investigations is included on the CD attached to the front cover.

This section briefly summarizes the types of data collected during each of these investigations and the data usability for the current RI/FS. Evaluation of data usability focused on the following five aspects of the data as recommended in *Guidance for Data Usability for Risk Assessment* (USEPA 1992):

1. ***Data Sources***—Evaluate the type of data collected (screening data, fixed laboratory data, etc.) and whether QA/QC samples are available for the data to provide data quality information
2. ***Analytical Methods and Detection Limits***—Evaluate methods for appropriateness and sensitivity and determine if detection limits are low enough for risk-based screening
3. ***Data Quality Indicators***—Review laboratory validation reports for data quality issues
4. ***Background Samples***—Assess whether appropriate quantity and location of background samples were collected
5. ***Consistency of Data Collection Methods***—Evaluate sample collection methods for appropriateness for the chemical, media, and analysis; review field trip notes

to assess quality of sample collection; and determine if differences in sample collection exist between different sampling events and investigations.

In the event that original reports were not available for evaluation of data quality, the data quality evaluation provided in the OESER RI/FS (E&E 2002a,b) was referenced for a summary of the data quality. Regarding data usability for risk assessment purposes, the following assumptions were made:

- Field screening data will not be used for risk assessment purposes.
- Unknown or tentatively identified compounds (TICs) will be excluded from consideration.
- If an analyte is not detected in any sample for a particular medium, then it will be assumed that the chemical is not present and it will be dropped from further consideration in the risk assessment. Note that sample quantitation limits (SQLs) will be compared to screening benchmarks as available, and a list of those compounds with SQLs above screening levels will be provided as part of the risk assessments.
- If an analyte has both detected and non-detect sample results (i.e., any results that include a "U" data qualifier), the assumed concentration in non-detect samples will be one-half of the SQL.
- For non-detect dioxin/furan congeners, two approaches will be followed for the calculation of 2,3,7,8-TCDD toxicity equivalency quotients (TEQs). In the first approach, one-half the SQL will be assumed for non-detects when calculating the TEQ for each sample. Under the second approach, non-detect concentrations will also be assumed to be present at a concentration of one-half the SQL, with the exception that if a congener is never detected in a particular medium, then it will be assumed to not be present, and it will be assigned a concentration of 0 when calculating TEQs (USEPA 2000a).
- For non-detect petroleum fractions, only the second of the above approaches will be used for calculating total volatile petroleum hydrocarbon (VPH)/extractable petroleum hydrocarbon (EPH). If a fraction is never detected in a particular medium, it will be assigned a concentration of 0. Otherwise, it will be assumed to be present at half the detection limit.

3.1.1 Site Inspection Report

Four sediment and two unfiltered surface water samples were collected in the vicinity of the Creek (locations JC-351 through JC-355, and JC-358) as part of the OESER facility investigation performed for EPA (E&E 1987). Semivolatile organic compounds (SVOCs) were analyzed in both media using EPA Method 8270. A data quality summary presented in the OESER RI indicated that there were only minor problems affecting data usability. However, other factors indicate that while these data can be used to assess data gaps, the data will not be included in the risk evaluation. These factors include: 1) age of the data – these data are approximately 17 years old and do not accurately represent current conditions in the creek, 2) media – sediment and surface water conditions are more likely to change over time than soil conditions, 3) analytes – SVOCs have the potential to volatilize or degrade over time, and 4) depth of sediment collection was not indicated in the database.

3.1.2 Site Hazard Assessment

Seven soil/sediment and five unfiltered groundwater/porewater samples were collected in the vicinity of the Creek (locations PMX-GW-10 through 15, PMX-SD-01 through 03, and PMX-SS-06 through 09) as part of the site hazard assessment (Parametrix 1991). SVOCs (EPA Methods 8270 and 8040) and total petroleum hydrocarbon (TPH) (EPA Methods 8015 and 418.1) were analyzed in both media. A data quality summary presented in the OESER RI indicated that there were several problems that affected data usability: 1) data quality was not addressed in detail, 2) holding times were exceeded, and 3) method blank detection limits were above sample detection limits. While these data will be cautiously used to assess data gaps, the data will not be included in the risk evaluation based on the following considerations: 1) age of the data – these data are approximately 13 years old and do not accurately represent current conditions in the creek, 2) media – sediment and porewater conditions are more likely to change over time than soil conditions, 3) analytes – SVOCs and TPH have the potential to volatilize or degrade over time, and 4) depth of sediment collection was not indicated in the database.

3.1.3 Wetland Mitigation Plan at Little Squalicum Creek

A total of 36 test or hand soil pits were dug within the boundaries of the Park as part of the Wetland Mitigation Plan (DEA 1993). Strata in each pit were classified and described using the Unified Soil Classification System (USCS). A note was made for each pit regarding whether groundwater was encountered and, if so, at what soil depth and relative volume. In 11 of the pits, soils from at least one strata were analyzed for moisture content and percent fines. These data will be carried forward for use in the RI/FS because soil strata and groundwater elevation levels are not likely to have changed since the data were collected. The only limiting factor regarding data interpretation is that location maps were hand drawn, and sample location coordinates were not provided in the report.

3.1.4 Site Inspection Prioritization Report

Eleven sediment samples were collected in the vicinity of the Creek (locations SI-BB01 through 03 and SI-LS01 through 08) as part of the Site Inspection Prioritization Report (URS 1994). SVOCs (EPA Method 8270) were analyzed. A data quality summary presented in the OESER RI indicated that there were no problems that affected data usability. These data will be used to assess data gaps; however, the data will not be included in the risk evaluation based on the following considerations: 1) age of the data – these data are approximately 10 years old and do not accurately represent current conditions in the creek, 2) media – sediment conditions are more likely to change over time than soil conditions, 3) analytes – SVOCs have the potential to volatilize or degrade over time, and 4) depth of sediment collection was not indicated in the database.

3.1.5 Expanded Site Investigation

Seven sediment, four unfiltered surface water, and three filtered surface water samples were collected in the vicinity of the Creek (locations OS01 through OS07) as part of the Expanded Site Investigation (ESI) (E&E 1996). SVOCs (Method Base Neutral Acid [BNA]) and metals (Methods AA, ICP/MS, and ICP-RAS) were analyzed in all media. A data quality summary presented in the OESER RI indicated that there were no problems that affected data usability. These data will be used to assess data gaps and will be included in the risk evaluation as part of the RI/FS.

3.1.6 Removal Assessment, Phase II

Three unfiltered surface water samples were collected in the vicinity of the Creek (locations 256, 320, and 343) as part of the Phase II Removal Assessment (E&E 1998a,b) conducted at the OESER site. SVOCs (EPA Methods 8270 and 8270 Selective Ion Monitoring [SIM]) and TPH (Method Northwest Total Petroleum Hydrocarbon [NWTPH]) were analyzed. A data quality summary presented in the OESER RI indicated that there were no problems that affected data usability. These data will be used to assess data gaps and will be included in the risk evaluation as part of the RI/FS.

3.1.7 OESER Company Remedial Investigation

The OESER RI (E&E 2002a) was the source for most of the historical data contained within the Park database. Types of data collected in the vicinity of the creek during the RI included groundwater (5 locations), berries (2 locations), seeps (2 locations), springs (1 location), subsurface soil leachate (1 location), surface water (7 locations), sediment (11 locations), bioaccumulation testing (3 locations), surface soil (87 locations), and subsurface soil (12 locations). Most of these media were analyzed for a full suite of analytes, including dioxins, EPA/VPH, TPH, volatile organic compounds (VOCs), SVOCs, metals, and conventionals. The data quality evaluation in the RI report indicated that all precision, accuracy, representativeness, completeness, and comparability goals were achieved for the RI field and analytical investigation. Validated analytical precision and accuracy showed that more than 99% of all target compound and target analyte data were acceptable for use. These data will be used both for data gaps analysis and for risk evaluation in the Park RI.

In addition to conventional and chemical analysis, biological testing was conducted as part of the OESER site RI (E&E 2002a) and included a 10-day toxicity test with the amphipod *Hyalella azteca*, and a 28-day bioaccumulation test with the aquatic oligochaete *Lumbriculus variegates*. Data quality of the biological testing results was deemed acceptable for use in the RI by EPA (refer to Section 3.6.5). These data will also be used both for data gaps analysis and for risk evaluation in the Park RI.

3.1.8 Little Squalicum Creek Screening Level Assessment

Ecology (2004) conducted the most recent investigation and evaluated six surface sediment samples (locations LSC01 through LSC06) and two surface soil samples (LSCS1 and LSCS2) in the vicinity of the Creek. All samples were analyzed for SVOCs using EPA Method 8270, and sediment samples were additionally submitted for bioassay testing. Bioassay tests conducted included a 10-day amphipod (*Hyalella azteca*), 20-day midge (*Chironomus tentans*), and Microtox® sediment porewater tests. The chemical data quality were of acceptable quality; however, some precision was lost in the analysis of SVOCs due to sample dilutions required because of hydrocarbon interference. Bioassay data were also of acceptable quality. These data will be used both for data gaps analysis and for risk evaluation in the Park RI.

3.2 HYDROGEOLOGIC DATA

Groundwater wells (MW-LSC-1 through MW-LSC-4) were installed along the old railroad grade located west of the Creek, and groundwater from these wells was evaluated during the OESER RI (E&E 2002a) (Figure 3-2). Groundwater was observed only a few feet below the ground surface and was characterized as a continuous aquifer with connections to the deeper of two zones identified on the OESER site located upgradient (north) of this Park area. Soils were described as primarily composed of coarse materials (i.e., sands and gravels).

Groundwater was measured over three sampling events in September 1999, December 1999, and February 2000. The data show that groundwater elevations were significantly higher in the middle well (MW-LSC-2), an anomalous mounding of groundwater. MW-LSC-2 appears to be located at the present terminus of the natural overland flow path toward the creek, designated by City staff as “Sugar Waste Gulch” on an old easement description. This area may represent a preferential groundwater flow path, such as a former stream bed to the Creek.

A mass balance of surface and storm drain water flowing into and out of the Creek was also conducted by E&E (2002a). They concluded the following:

- The headwaters of the creek originate with the storm drain outflows from the combined OESER/Birchwood outfall to the west (north) and the Birchwood/BTC outfall from the east.
- The creek terminates with the culvert that empties onto the beach at Bellingham Bay.
- During the dry season, tapped spring flows account for about one-third of the flow from the creek.
- During the rainy season, virtually all flow from the creek can be traced back to stormwater runoff entering the creek through the three storm drain systems that service the surrounding area (including Marine Drive storm drain).

3.3 GEOTECHNICAL AND OTHER PHYSICAL PARAMETERS

As part of the Creek Wetlands Compensation Project, Landau Associates conducted a geotechnical evaluation to assist in wetlands and stream channel design within the Park as compensation for wetlands lost during a planned expansion of the Bellingham International Airport (DEA 1993). Landau was a subconsultant to David Evans and Associates, who was contracted with the Port of Bellingham.

Subsurface conditions were evaluated on the site by excavating 22 backhoe test pits and 6 hand explorations in October 1992 (Figure 3-4). The depth of these excavations ranged from 1 to 6 ft below ground surface (bgs). Selected soil samples were analyzed for grain size and moisture content. The following observations and conclusions were made by Landau:

- Soil conditions were variable and included clean (low silt/clay content) sand and gravel, silty sand and gravel, and occasional silt and clay units.
- Fill materials including wood, metal, glass, and ash debris were encountered at several locations in the northeast to central portion of the site.
- One location, test pit SC-20, contained significant amounts of glass and other household refuse. This location is near the BTC parking lot.
- Groundwater was encountered at six test pit locations in the northeastern portion of the site ranging from approximately 2 to 5-1/2 ft bgs (October 1992).
- Most soil appears to be moderately to highly permeable. As a result, Landau recommended a low permeability liner within the new stream channel location and applicable wetland cells to reduce water loss by infiltration (DEA 1993).

3.4 HABITAT CHARACTERISTICS

The Creek begins at the Birchwood neighborhood outfall (underground pipe from the east) and ends approximately 1,500 ft downstream at Bellingham Bay. The creek channel ranges in width from approximately 5 to 10 ft, with water depths usually less than 1 ft in most places. The creek is fed by three stormwater outfalls (the east Birchwood neighborhood, Birchwood/OESER, and Marine Drive outfalls), two tapped springs, and several small seeps (E&E 2002a). Water flow is observed during the wetter season (October through May), but during the drier season the creek bed may be exposed.

As indicated by E&E (2002a), numerous benthic invertebrate taxa, including caddisfly larvae, midge larvae, amphipods, snails, and aquatic oligochates, were observed in the Creek during the OESER RI fieldwork. These observations suggest that the creek supports reproducing populations of benthic organisms. The Creek, however, does not support fish, although some salmonid fingerlings have been found as far upstream as the Marine Drive Bridge. It is assumed that they swam into this area of the creek during a high tide or storm event and that they remained in this area for only a short time before returning to Bellingham Bay. (An elevated cement culvert near the mouth of the creek provides an obstacle to fish that can only be overcome during such high-water events.)

The creek channel and other areas in the Park are shaded by a well-developed overstory of alder, willow, and black cottonwood trees. Common plant species in the understory include grasses, horsetail, blackberry, hawthorne, holly, and saplings of alder, willow, cottonwood, mountain ash, fir, and cedar (E&E 2002a).

3.5 SCREENING LEVEL CRITERIA

This section presents the ARARs for the purposes of selecting a screening benchmark for evaluating historical data and selecting analytes to carry forward for the RI/FS. Screening benchmarks were compiled based on human health toxicity, ecological toxicity, natural background conditions in Puget Sound, and available site-specific background concentrations. In general, if benchmarks were available from multiple sources for a single analyte, the lowest concentration was selected as the screening benchmark for the purposes of this data gaps analysis. The array of screening benchmarks considered and the selected screening levels for each medium are included with this document.[3] Sources of benchmarks evaluated for each medium are summarized below.

[3] Tables presenting screening benchmarks for soil, groundwater, surface water, and soils are included on the CD attached to the front cover.

3.5.1 Soil

Available historical data for soil include onsite surface and subsurface soil data and background surface soil data. Given that some surface and subsurface soils onsite also have the potential to become sediment in the event that the creek is rerouted, screening benchmarks for sediment were considered in addition to screening benchmarks for soil. There are no human health sediment benchmarks, but there are ecological sediment benchmarks.[4] Screening benchmarks for soil were obtained from the following sources:

- MTCA Method B – Direct Human Contact to Soil, obtained from CLARC Version 3.1 (Ecology 2001a)
- U.S. EPA Region 9 Preliminary Remediation Goals (PRGs) for soil leaching to groundwater, obtained from http://www.epa.gov/region09/waste/sfund/prg/index.htm (October 2004)
- MTCA Terrestrial Ecological Evaluation (TEE) Indicator Soil Concentrations for plants, soil invertebrates and wildlife, obtained from MTCA Table 749-3 (Ecology 2001b)
- Freshwater Sediment Lowest Apparent Effect Thresholds (LAETs), obtained from Ecology (2003)[5]
- Marine Sediment Quality Standards, obtained from WAC 173-204 (Ecology 1995)[6]
- Puget Sound regional background soil concentrations (Ecology 1994)
- Site-specific background soil concentrations (surface and subsurface).

The screening levels (SL) were prioritized such that the minimum value of the screening values was used as the SL unless it was less than either of the background concentrations (site-specific or regional), in which case it was adjusted up to the maximum background concentration. For SL values that are normalized to total organic carbon (TOC), but were unavailable for a data set, a TOC value of 1.0% was assumed in normalizing these data. A TOC value of about 1.0% was typically measured in soils and sediments of the Park.

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[4] Human health benchmarks are based upon accumulation of all exposure pathways and the affected populations, but not upon strict direct numerical criteria.
[5] Freshwater LAETs are used for guidance only. Sediment bioassays are the definitive tool for evaluation of ecological risk in freshwater systems.
[6] Marine Sediment Quality Standards are screening criteria. Sediment bioassays are the definitive tool for evaluation of ecological risk in marine systems.

3.5.2 Groundwater

Available historical data for groundwater include unfiltered and filtered samples from onsite and background locations. Filtered samples were only analyzed for metals. Screening benchmarks for groundwater came from the following human health and ecological sources:

- Washington State Criteria (WAC 173-201A-040)
- National Ambient Water Quality Criteria – freshwater chronic and human health consumption of water and organisms (USEPA 2002)
- Tier II Secondary Chronic Values (SCV) (Suter and Tsao 1996)
- EPA Region 5 Ecological Screening Levels (USEPA 2003)
- EPA Region 6 Ecological Screening Benchmarks (TNRCC 2001)
- MTCA Method B Surface Water – Ingestion of Fish, obtained from CLARC Version 3.1 (Ecology 2001a)
- Federal MCLs (USEPA 2005)
- State MCLs (WAC 246-290-310)
- MTCA Method B Groundwater.

The preliminary groundwater screening levels were developed in three steps. First, the ecological screening level was identified. The minimum (lower concentration) of the Washington State criterion and the National Ambient Water Quality criterion was selected. If no value was available from either of those sources, the SCV was selected. If no SCV was available, the EPA Region 5 ESL was selected. If no EPA Region 5 ESL was available, the EPA Region 6 benchmark was selected.

Second, the potable groundwater screening level was identified as follows. The state MCL was the preferred screening level. If no state MCL was available, the federal MCL was used. If no federal MCL was available, the MTCA Method B groundwater level was used.

Finally, the ecological and the potable groundwater screening levels were compared with the MTCA Method B surface water level, and the lowest of the three was selected as the risk-based screening level. If the background concentration exceeded the risk-based screening level, the background concentration was used as the final screening level. Background groundwater concentrations were evaluated using well MW-06D, located northeast of the OESER site near Cedarwood Avenue. MW-06D has been sampled on 12 different occasions since 1995, the most recent of which was during the OESER RI conducted by E&E on behalf of EPA (E&E 2002a).

EPA equilibrium partitioning model will be used in the RI to evaluate groundwater concentrations that could re-contaminate sediments.

3.5.3 Surface Water and Porewater

Available historical data include unfiltered water analytical data for surface water, springs, seeps, and porewater, and filtered water analytical data for surface water, springs, and seeps. The sources and hierarchy of screening levels discussed in Section 3.5.2 for groundwater was used for surface water, except no acceptable background data were available for surface water and no screening levels associated with potable water (MCLs and MTCA Method B groundwater) were used. The screening levels for protection of aquatic life and for humans eating fish from the creek are considered at this time sufficiently protective for incidental and occasional consumption of creek water. The creek has insufficient flow to provide a year-round source of drinking water to meet daily needs.

3.5.4 Surface Sediment

Available historical data for sediment includes samples from onsite locations. Given that surface sediments onsite also have the potential to become soil in the event that the creek is rerouted, screening benchmarks for soil were considered in addition to screening benchmarks for sediment. There are no human health sediment benchmarks, but there are ecological sediment benchmarks.[7] Screening benchmarks for sediment were obtained from the following sources:

- MTCA Method B – Direct Human Contact to Soil, obtained from CLARC Version 3.1 (Ecology 2001a)
- U.S. EPA Region 9 PRGs for soil leaching to groundwater, obtained from http://www.epa.gov/region09/waste/sfund/prg/index.htm (October 2004)
- MTCA TE Indicator Soil Concentrations for plants, soil invertebrates and wildlife, obtained from MTCA Table 749-3 (Ecology 2001b)
- Freshwater Sediment LAETs, obtained from Ecology (2003)[8]
- Marine Sediment Quality Standards, obtained from WAC 173-204 (Ecology 1995)[9]

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[7] Human health benchmarks are based upon accumulation of all exposure pathways and the affected populations, but not upon strict direct numerical criteria.
[8] Freshwater LAETs are used for guidance only. Sediment bioassays are the definitive tool for evaluation of ecological risk in freshwater systems.
[9] Marine Sediment Quality Standards are screening criteria. Sediment bioassays are the definitive tool for evaluation of ecological risk in marine systems.

- Puget Sound regional background soil concentrations, obtained from Ecology (1994).

The screening levels were prioritized such that the minimum value of the screening values was used as the SL.

3.5.5 Biological Analyses

There are no screening levels associated with the biological analyses that were conducted at the site. Biological testing of site samples followed EPA, Ecology, and American Society for Testing and Materials (ASTM) Methods (USEPA 1994, Ecology 2003, ASTM 1997) and included 10-day toxicity testing of sediment with the freshwater amphipod *Hyalella azteca*, a 20-day test assessing mortality and growth of the midge *Chironomus tentans*, a 28-day sediment bioaccumulation test with the freshwater oligochaete *Lumbriculus variegates*, and the Microtox® sediment porewater test. Testing results are discussed further in Section 3.6.5.

Freshwater sediment biological assessment methods are outlined in Ecology's Sampling Analysis Plan Appendix (Ecology 2003). These include the following:

- 10-day and 20-day sediment toxicity test that assesses mortality and growth of the midge *Chironomus tentans*
- 96-hour sediment toxicity test that assesses mortality and developmental malformations in embryos of the frog *Xenopus laevis*
- Microtox® 100 percent sediment porewater extract test
- 10-day and 28-day sediment toxicity test that assesses mortality and growth of the amphipod *Hyalella azteca*.

3.6 DATA SCREENING

Analytes with detected concentrations exceeding SLs were considered as potential indicator hazardous substances (IHSs). This section summarizes the degree to which detected concentrations exceeded the thresholds presented in Section 3.5 for each medium. Raw analytical data have been assembled from historical reports into the Integral database for this project. The magnitude by which detected concentrations exceeded screening levels is presented for each media in Tables 3-1 through 3-7.

3.6.1 Soil

Both surface soil and subsurface soil data were available for comparison to screening levels. Results are discussed below.

3.6.1.1 Surface Soil

A total of 20 background samples collected during the OESER RI (E&E 2002a) and 102 site samples collected during the OESER RI (100 samples) and the Ecology (2004) investigation were evaluated. Most of the site surface samples (95) only had TPH field screening analysis performed (method used was laser-induced fluorescence or LIF). None of the detected compounds in background soil samples exceeded screening levels. Surface soils from the site, however, had 48 analytes with detected concentrations exceeding screening levels. Exceedances were found for the following analyte classes (number of individual analytes indicated in parentheses): dioxin (1), metals (12), SVOCs including polycyclic aromatic hydrocarbons (PAHs) and PCP (34), and petroleum hydrocarbons (1). The number of samples exceeding screening levels for these analytes is shown in Table 3-1. TPH had the most number of samples (50) exceeding screening levels. Several ubiquitous metals (barium, vanadium, and zinc) had more than 10 exceedances while many SVOCs only had one sample exceeding screening levels.

3.6.1.2 Subsurface Soil

A total of two background samples collected during the OESER ESI (E&E 1996) and 24 site samples collected during the OESER RI were evaluated. None of the detected compounds in background soil samples exceeded screening levels. Site subsurface soils, however, had six analytes (all metals) with detected concentrations exceeding screening levels. These metals included barium, copper, mercury, nickel, vanadium, and zinc. The number of samples exceeding screening levels for these metals is shown in Table 3-2.

3.6.2 Groundwater

Groundwater data available for screening include background data from one well (MW-06D) – 19 unfiltered samples and eight filtered samples, and site data from five wells – 11 unfiltered samples and six unfiltered samples. Filtered groundwater was only analyzed for metals. Background unfiltered groundwater had one analyte with a detected concentration exceeding its screening level – benzo(a)anthracene (Table 3-3). Background filtered groundwater had an exceedance for one metal – thallium (Table 3-4). Site filtered groundwater had exceedances for four metals – barium, cadmium, magnesium, and manganese (Table 3-4). Site unfiltered groundwater had 24 analytes with detected concentrations exceeding screening levels - 21 SVOCs and three metals (Table 3-3). Most of the exceedances for SVOCs occurred only in WP1.[10] Barium and magnesium had more exceedances than the other analytes (4 and 6, respectively).

[10] WP-1 is a shallow well point; hand installed approximately 1 to 2 feet into the center of the creek channel.

3.6.3 Surface Water

A total of 32 site samples provided data for the concentration screening evaluation. These data include samples collected during the ESI (4 surface water samples; E&E 1996), the RA Phase II (3 surface water samples; E&E 1998a,b), the SI (2 surface water samples; E&E 1987), the OESER RI (13 surface water samples, 2 spring samples, and 3 seep samples; E&E 2002a), and the site hazard assessment (5 porewater samples; Parametrix 1991). Both unfiltered and filtered samples were analyzed; filtered samples were only analyzed for metals. Site unfiltered surface water had 23 analytes with detected concentrations exceeding screening levels. Exceedances were found for the following analyte classes (number of individual analytes indicated in parentheses): dioxin (1), metals (8), and SVOCs (14). The number of analytes exceeding screening levels totaled 145, as shown in Table 3-5. Barium, magnesium, and arsenic had the most number of samples (20, 19, 15) exceeding screening levels. Site filtered surface water had exceedances for four metals – aluminum, arsenic, barium, and magnesium (Table 3-6).

3.6.4 Surface Sediment

Data from a total of 54 site surface sediment samples were available for comparison to screening levels; these data were generated as part of several of the historical investigations discussed above. Site samples had 54 analytes with detected concentrations exceeding screening levels. Exceedances were found for the following analyte classes (number of individual analytes indicated in parentheses): dioxins (1), SVOCs (38), petroleum hydrocarbons (1), and metals (14). The number of chemical screening level exceedences within the 54 surface samples totaled 584, as shown in Table 3-7. Eighty percent (471) of the screening level exceedances were for SVOCs and 15% (92) were for metals. Most of the SVOC exceedances (362) were for PAHs. The metals most frequently in exceedance were vanadium (19), zinc (16), and copper (8).

3.6.5 Biological Analyses

This section summarizes results of biological analysis that include sediment toxicity testing, sediment bioaccumulation testing, and berry analysis conducted as part of the OESER Site RI (E&E 2002a) and sediment toxicity testing that was conducted more recently by Ecology (2004). Results are presented in Appendix B.

3.6.5.1 Sediment Toxicity and Bioaccumulation (OESER RI)

Biological analytical results were conducted as part of the OESER site RI (E&E 2002a) and included a 10-day toxicity test with the amphipod *Hyalella azteca* and a 28-day bioaccumulation test with the aquatic oligochaete *Lumbriculus variegates.*[11]

Sediment toxicity testing with *H. azteca* was conducted on samples from eight locations (SD1 through SD8) in the Creek, one location in the channel that leads from the OESER outfall to the creek (SD10), and one location at the Birchwood outfall (SD9), which is considered a site-specific background sample. The Birchwood neighborhood outfall is upstream from the confluence of the OESER outfall channel with the creek. Results are contained in Appendix B, Table B-1.

The two test endpoints evaluated were survival and growth. The average percent survival in samples from the creek and OESER outfall channel ranged from 78 to 93%; average percent survival in the background station was 91%. None of the site survival results differed significantly from the survival results in the background sample. The average dry-weight per organism (amphipod growth) in samples from the creek and OESER outfall channel ranged from 0.13 mg to 0.20 mg; average dry weight per organism in the background station was 0.24 mg. It is not known if the growth results in the site samples are significantly different from the growth in the background sample because it was not reported in the OESER RI, and the raw data are not available to make this comparison. It should be noted, however, that average amphipod growth in the laboratory control was only 0.10 mg per organism.

Sediment bioaccumulation testing with *L. variegatus*, was conducted on sediment from three locations in the Creek (SD2, SD5, and SD6). Results are contained in Appendix B, Table B-2 and B-3. Following the 28-day exposure period, the oligochaetes were removed from the sediment and analyzed for bioaccumulative chemicals of concern (COCs), which included several SVOCs (phenols, PAHs, benzoic acid, and benzyl alcohol), and dioxins/furans. At test termination, the average biomass per replicate in the site samples was 3.7 g, 2.9 g, and 11.2 g, respectively, for samples SD2, SD5, and SD6. The average biomass per replicate in the laboratory control was 8.9 g and biomass at test initiation for all samples was 10 g. These data indicate that growth only occurred in sample SD6, the other two site samples and the control each lost weight during the test. The weight loss in samples SD2 and SD5 was significantly greater than the weight loss in the control, suggesting either a toxic effect at these two locations, or significantly reduced food availability. Over the 28-day test period, the worms are not fed and instead must rely on available organic carbon in the sediment to sustain their dietary requirements. The

[11] It should be noted that the methods and number of tests performed as part of the OESER RI did not follow the requirements of the Washington State Sediment Management Standards, which is an ARAR for this site.

percent TOC in the site samples were 1.3% (SD2), 1.8% (SD5), and 11% (SD6), suggesting that differences in food availability may have contributed to the differences in biomass between the site samples.

The limited biomass obtained from each of the site samples at test termination prevented the analysis of the entire analytical suite at each location, with the exception of the control sample. Rather, analyses were split between the samples: sample SD6 was analyzed for SVOCs, and the biomass from samples SD2 and SD5 was pooled and analyzed for dioxin. Results are summarized in Appendix B along with the corresponding sediment concentrations. Eleven PAHs, six phenols, and two other SVOCs (benzoic acid and benzyl alcohol) were detected in organisms exposed to sediment from location SD6. However, five of these analytes (2,4,6-trichlorophenol, 2-methylphenol, phenol, benzoic acid, and benzyl alcohol) were not detected in sediment from SD6. Seven dioxin/furan congeners were detected in the organisms exposed to sediment from locations SD-02 and SD-05. As compared to sediment dioxin concentrations at these two locations, each of the seven dioxin congeners was also detected in sediment at SD2 and SD5 except for 1,2,3,4,7,8-HxCDD, which was non-detect at both locations.

3.6.5.2 Berry Testing (OESER RI)

Four composite berry samples from Himalayan blackberry (*Rubus discolor*) bushes were collected from the following locations:

- Berry 1: collected by the railroad tracks immediately south of the OESER Company facility
- Berry 2: collected along the old railbed/path above the Creek
- Berry 3: collected from the ravine on the south side of the creek
- Berry 4: collected from a residential background area approximately at the intersection of Squalicum Parkway and Meridian Street in Bellingham, WA.

From all four locations, washed (rinsed with distilled water) and unwashed berries were analyzed for VOCs, SVOCs, and dioxin. Analytes that were detected at least once are presented in Appendix B (Table B-4) and include six PAHs, three other SVOCs (1,2,3-trichlorobenzene, benzoic acid, and benzyl alcohol), two VOCs (p-isopropyltoluene and styrene), and three dioxin/furan congeners (1,2,3,4,6,7,8-HpCDD, OCDD, and OCDF). As expected, in general, concentrations in unwashed berries were greater than concentrations in washed berries. The SVOC 1,2,3-trichlorobenzene was only detected in the washed background sample. All other SVOCs, except from fluoranthene and phenanthrene, were only detected in site samples. Concentrations of fluoranthene and phenanthrene in the berry samples from the site were within the range of concentrations observed in the background sample. The two VOCs were detected in all samples, and concentrations in berry samples from the site bracketed concentrations observed in the background sample. The compounds p-isopropyl toluene, benzoic acid, and benzyl alcohol are naturally occurring in berries. Of the three dioxin congeners detected, two (1,2,3,4,6,7,8-HpCDD and OCDF) were only detected in the site samples. Octachlordibenzo-p-dioxin (OCDD) was detected in all samples except for the washed berries from the background station; site concentrations bracketed the background concentration. Tetrachlorodibenzo-p-dioxin (TCDD) toxicity equivalency quotients (TEQ) concentrations in unwashed berries consistently exceeded concentrations in washed berries, and site concentrations exceeded background concentrations. Based on these results, the risk assessment in the OESER RI concluded that consumption of berries was not an exposure pathway of concern. No additional sampling of berries is planned for the Park RI.

3.6.5.3 Sediment Toxicity (Ecology)

In September of 2003, Ecology collected six surface sediment samples (locations LSC01 through LSC06) and two surface soil samples (LSCS1 and LSCS2) in the vicinity of the Creek (Ecology 2004). Only the sediment samples were submitted for bioassay analysis; however, all samples were analyzed for SVOCs. Three toxicity tests with three different species conducted on the sediment samples were a 10-day amphipod (*Hyalella azteca*), 20-day midge (*Chironomus tentans*), and Microtox® tests. Sediment toxicity results are presented in Appendix B (Table B-5).

Results indicated that five of the six sediment samples LSC02, LSC03, LSC04, LSC05, and LSC06 showed toxicity as follows:

- LSC02: mean survival was significantly reduced in the 20-day *C. tentans* test as compared to survival in the reference sample. Growth, however, was greater in this sample than in the reference. The bioassay results at this station indicate exceedances of the recommended freshwater Cleanup Screening Level (CSL) endpoint.
- LSC03: mean survival was significantly reduced in the 10-day *H. azteca* test as compared to survival in the reference sample. Mean survival and growth were significantly reduced in the 20-day *C. tentans* test as compared to survival and growth in the reference sample. Microtox® light output was significantly reduced as compared to light output in the reference sample. The bioassay results at this station indicate exceedances of the recommended freshwater CSL endpoint.
- LSC04: mean survival was significantly reduced in the 10-day *H. azteca* test as compared to survival in the reference sample (an exceedance of the freshwater CSL endpoint).
- LSC05: Microtox® light output was significantly reduced as compared to light output in the reference sample (an exceedance of the freshwater SQS endpoint).

- LSC06: mean survival was significantly reduced in the 10-day *H. azteca* test as compared to survival in the reference sample. Microtox® light output was significantly reduced as compared to light output in the reference sample. The results for LSC06 represent a CSL exceedance based on the combined results from the *H. azteca* and Microtox bioassays.

3.7 PRELIMINARY CONCEPTUAL SITE MODEL

At this phase of the RI/FS, the CSM presents a preliminary understanding of site conditions. Integral developed the CSM from the information presented in Section 3.6 and general knowledge of site conditions and contaminant transport behavior. Development of a CSM early in the RI/FS process helps identify data gaps and guide collection of data appropriate for assessing risks and remedial actions. The CSM will be refined throughout the project as additional data are collected and site conditions are better understood. The CSM, illustrated in Figure 3-5 and described in Table 3-8, includes sources of contaminants, transport pathways, and potential exposure pathways for human and ecological receptors.

3.7.1 Sources

Several potential contamination sources have been identified for surface soils and surface waters in the Park. OESER disposed of wood-treating wastes north of the creek near the OESER site boundary. In some cases, discharge of process wastewater or contaminated stormwater may have occurred directly into the creek bed and surrounding areas (refer to Section 2). A stormwater pipe combining discharge from OESER and portions of the Birchwood neighborhood (another potential source) discharges to the creek from the north side. Likely contaminants from these activities include the following:

- PCP, a wood treating chemical
- Diesel-range organic hydrocarbons (DRO), used as a carrier for PCP
- Dioxins and furans, common contaminants of PCP
- PAHs, components of both DRO and the wood treating mixture in creosote
- Gasoline-range organic hydrocarbons (GRO) from vehicular activities.

An outfall conveys nonpoint source runoff from Marine Drive into the Creek at the south end of the bridge. A stormwater pipe combining discharge from the BTC campus and portions of the Birchwood neighborhood discharges to the Creek from the south side. A culvert discharges from the BTC parking lot into the southeast corner of the Park. The petroleum released from Marine Drive and the college could be GRO or DRO. Additional potential contaminants from these facilities include a variety of SVOCs including PAHs and phthalates, both of which are common in urban runoff, and metals from vehicular activities and general urban runoff.

A gravel pit operated south of the creek, both east and west of Marine Drive. Gravel operations could have been a source of petroleum hydrocarbons (DRO) from the use of motorized equipment (e.g., diesel fuel and motor oil).

Historically, a construction material landfill operated beneath what is now a portion of the BTC parking lot. Based on historical sampling, a debris field was documented in the southeast corner of the Park near BTC. The debris is believed to be primarily construction materials rather than municipal landfill materials.

The BNSF railroad tracks could be a source of pesticides and DRO, including PAHs, to the soils in the vicinity of the tracks. Pesticides and oily products have been reportedly used to treat the wood in the ties and to control vegetation along the tracks.

3.7.2 Transport Pathways

Infiltration from rainfall could cause contaminants in surface soils to leach to subsurface soils and eventually to groundwater. Shallow groundwater might discharge into the creek. The groundwater is also hydraulically connected to Bellingham Bay. Groundwater contaminants could eventually reach surface water and sediments in the creek, the bay, or both.

Soil contaminants could be carried in surface runoff to the surface water in the Creek. Some of the contaminants in surface water could bind to sediments in the creek. Other surface water contaminants could be carried down the creek to the beach and the surface water and sediments of Bellingham Bay.

Many of the contaminants that reach the mouth of the creek are likely to be dispersed into Bellingham Bay because the beach is a highly exposed area with a great deal of erosion. The shallow portions of the beach are primarily cobbles and gravel, with little fine-grained sediments to adsorb chemicals.

Soils in areas not covered by vegetation could become airborne and transported by wind. If GRO is present from urban runoff, some volatilization could occur. The other contaminants of interest are not volatile, so volatilization is not likely to be an important transport pathway for them.

Contaminants in surface and subsurface soil could be taken up by plants and soil-dwelling invertebrates. Contaminants in surface water and sediments of the creek or the bay could be ingested by benthic organisms (animals and plants living in the sediments).

In addition, if the creek were rerouted to another portion of the park, sediment would become soil and soil would become sediment, changing potential pathways for contamination at any given location. If excavation takes place to create a "new" creek bed for the rerouted creek, formerly buried contamination could be exposed and thus potentially transported elsewhere.

3.7.3 Potential Receptor Populations and Exposure Pathways

Potential human receptors include the following:

- Recreational park users
- Maintenance workers working in the park
- Residents near the park
- Workers at BTC, OESER, and other work sites near the park.

Potential ecological receptors include the following:

- Terrestrial and aquatic plants
- Soil-dwelling invertebrates (e.g., worms)
- Terrestrial animals (e.g., birds, mammals, amphibians, and reptiles)
- Domesticated animals (e.g., dogs)
- Various fish species (e.g., salmonids)
- Benthic invertebrates (e.g., snails).

Park users, maintenance and construction workers, and terrestrial animals could be exposed to contaminants in surface soil by direct contact (unintentional ingestion and absorption across the skin) with the soil or by inhalation of airborne particulates. Residents, workers, and terrestrial animals near the park could inhale dust blown out of the park. Terrestrial plants could take up contaminants from surface and shallow subsurface soils and consume contaminated plants or soil-dwelling invertebrates while foraging for food in the park. Park users could be exposed to contaminants by ingesting local plants (e.g., berries).

If park development or maintenance activities uncovered subsurface soil, park users, maintenance workers, and terrestrial animals could be exposed to the subsurface soil through direct contact or inhalation. The subsurface soil would be come available for windblown transport to residents, workers, and terrestrial animals near the park. If the creek is re-routed, surface and subsurface soils could be converted to sediments with sediment/biota exposure routes.

Ecological receptors are not likely to be exposed directly to groundwater, because groundwater is likely deeper than the active zone for plant roots and burrowing animals (typically 6 ft). Pending future site investigations, the groundwater is assumed to be potable if a well were drilled; though it is unlikely a well will be drilled in the park. If a well were drilled, users could be exposed through ingestion of the water, dermal contact with the water, and inhalation of vapors generated during household activities such as showering. As discussed in Section 3.7.2, groundwater contaminants could be transported from upgradient sources to the Creek, Bellingham Bay, or both.

Park users could be exposed to contaminants in surface water and sediments through direct contact while recreationally using the Creek. Park maintenance workers are unlikely to have much contact with the creek. Terrestrial animals could be exposed to surface water and sediments through direct contact while foraging for prey and through intentionally drinking the water. Terrestrial animals could also be exposed by eating contaminated prey in the creek.

If groundwater or surface water contaminants reach Bellingham Bay, humans could be exposed through direct contact with water and sediments while collecting shellfish or wading recreationally and through ingestion of shellfish caught locally. Birds or animals preying on shellfish and fish migrating into the Creek could also be exposed through direct contact with the surface water and the sediments and through ingestion of the shellfish and fish.

3.8 DATA GAPS

Data gaps can include the following issues:

- Poor data quality
- Inappropriate analytes
- Lack of data for an area or at depth (spatial)
- Lack of current data (temporal)
- Undefined media (sediment vs. soil) and exposure routes.

Section 3.1 discussed the quality of data collected previously at the site. Because of age, data quality problems, or both, this analysis will not use any of the chemical data collected prior to 1996. However, the physical data collected by Landau (DEA 1993) will be used. This eliminates only a small portion of the total data available. Most of the samples have been analyzed for the contaminants of interest (TPH, SVOCs, PAHs, metals, and dioxins/furans). The discussion of data gaps will focus on spatial and temporal issues, based on a review of available data and locations of site concentrations that exceed SLs (Section 3.6).

3.8.1 Soils

Soil data gaps are primarily spatial. Although soils along the slope north of the Creek near the OESER property have been studied, no recent soil data are available for the old gravel pit areas on the south side of the Creek. Limited data are available in the vicinity of the railroad tracks (BNSF) and the stormwater discharge from BTC. Soil sampling will focus on these three areas southeast of the Creek. A pattern regarding metals contamination in soils was noted during the OESER RI (E&E 2002a). Several metals appear to be elevated in the area of the Park, so metals analyses will be of interest in the Park RI/FS.

Soil sampling at depth in the areas south of the Creek is necessary because of the possibility of rerouting the Creek into these areas. It might be necessary to dig a new streambed or the re-routed stream might erode surface soils, either of which could expose deeper soils. An understanding of the chemical and physical characteristics of soils in these areas is important for completion of the RI.

Temporal issues are not expected to be an important concern for soils. VOCs detected in surface soil samples more than a couple years ago may have volatilized, so they would be present at lower or nondetectable concentrations now (presuming no additional deposition since the earlier sampling events). Risk estimates based on older soil VOC data could be biased high. However, few VOCs have exceeded their SLs in previous investigations. Since VOCs are not expected to be important chemicals of concern, this chemical group is not proposed for further soils testing.[12]

3.8.2 Groundwater

Groundwater does not appear to be a medium of primary concern at the Park based on sampling and testing results in the OESER RI. No additional wells are proposed within the boundaries of the Park. However, additional groundwater sampling of wells located downgradient of the OESER site is warranted to provide current data for evaluating potential risk to humans and the environment. Piezometers may be installed in selected soil sampling locations to monitor seasonal fluctuations in shallow groundwater (refer to Section 4.2.1).

[12] Soil vapors are typically not a concern at levels historically detected at the site. This pathway will be evaluated in the RI pending the results of this sampling event.

3.8.3 Surface Water

Data gaps for surface water are primarily temporal. Contaminant concentrations in the surface water of the Creek are expected to vary over time because of variable inputs from upstream sources and the discharges from Marine Drive, OESER, BTC, and the Birchwood neighborhood. Additional surface water sampling is warranted to provide current data, focusing on discharge areas and identification of sources.

3.8.4 Sediments

Sediment data gaps are both spatial and temporal. Sediment concentrations in the Creek are expected to vary to some extent over time because of interactions with surface water; therefore, older data may not be entirely representative of current sediment conditions. The sediment sampling in the Creek has encompassed most of the length of the creek, but it has not characterized the depth or width of the contaminated sediments. These spatial issues will be important if sediment remediation is warranted.

A round of sediment sampling, at both surface and depth, is warranted to provide current data, focusing on bounding areas of higher concentrations detected in previous sampling efforts and conducting transects across the creek to identify the lateral and vertical extent of sediment contamination.

The highly eroded nature of the beach and the results of previous investigations indicate a low level of concern for the beach located at the mouth of the Creek. Nevertheless, since humans may collect shellfish at the beach, additional beach sediment samples (if sufficient fine-grained sediments can be found within the discharge area of the Creek) will be collected to verify that potential contamination does not pose a health threat.

Sediment in the creek may potentially be reclassified as "soil" if the creek is rerouted to other areas of the Park. Consequently, sediment collected in the creek will be tested as if it will be soil. In addition, soil in the area where the creek could be rerouted will be tested as if it would (later) be sediment.